

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

LISTING OF CLAIMS:

1. (original): A spindle unit comprising:

a rolling bearing including an outer ring having an outer ring raceway on an inner peripheral surface, an inner ring having an inner ring raceway on an outer peripheral surface, and rolling elements provided rollably between the outer ring raceway and the inner ring raceway, whereby a spindle is borne rotatably in a housing; and

a grease supply system for supplying a grease to an inside of the rolling bearing;

wherein the grease supply system supplies the grease such that a supply amount in one shot is set to 0.004 cc to 0.1 cc.
2. (original): A spindle unit according to claim 1, wherein the grease supply system contains a supply hole provided in the outer ring.
3. (withdrawn): A spindle unit according to claim 1, further comprising an outer ring spacer;

wherein the grease supply system contains a supply hole provided in the outer ring spacer.
4. (original): A spindle unit according to claim 1, wherein the grease supply system contains a supply hole provided in the housing.

5. (withdrawn): A spindle unit according to claim 1, further comprising at least one rotating body arranged in vicinity of a side surface of the inner ring or the outer ring; and wherein the grease is exhausted to an outside of the rolling bearing by a rotation of the rotating body.

6. (withdrawn): A spindle unit according to claim 5, wherein a storage space for storing the exhausted grease is provided in the housing.

7. (withdrawn): A spindle unit according to claim 1, further comprising at least one exhaust hole for exhausting the grease to an outside of the spindle unit; and wherein the grease is stored in the exhaust hole.

8. (withdrawn): A spindle unit according to claim 5, wherein the rotating body is composed of a collar that is formed in at least one of an inner ring spacer, the inner ring, and a cage of the rolling bearing.

9. (withdrawn): A spindle unit according to claim 7, wherein the grease is exhausted by pouring another fluid different from the grease into the exhaust hole from an outside.

10. (withdrawn): A spindle unit according to claim 1, further comprising a rotation speed sensor for sensing a rotation speed of the spindle; and

wherein the grease supply system supplies the grease into an inside of the rolling bearing in response to the rotation speed.

11. (withdrawn): A spindle unit according to claim 10, wherein the grease supply system divides the rotation speed into a plurality of areas to assign an addend to the plurality of areas respectively, then calculates an integrated value by integrating the addend corresponding to the measured rotation speed every unit time, and then supplies the grease when the integrated value exceeds a predetermined value.

12. (withdrawn): A spindle unit according to claim 11, wherein the grease supply system resets the integrated value at a time of grease supply, and integrates a number of resets of the integrated value.

13. (withdrawn): A spindle unit according to claim 11, wherein the grease supply system sets the addend to 0 and does not execute an integration when the spindle is stopped.

14. (withdrawn): A spindle unit according to claim 10, wherein the grease supply system controls the rotation speed of the spindle smaller than a predetermined rotation speed when a residual amount of grease in the grease supply system is reduced smaller than a predetermined value.

15. (withdrawn): A spindle unit according to claim 11, wherein the grease supply system controls the rotation speed of the spindle smaller than a predetermined rotation speed

when a residual amount of grease in the grease supply system is reduced smaller than a predetermined value, and

the predetermined rotation speed belongs to a rotation speed area that is one rank lower than a maximum rotation speed area in the plurality of areas.

16. (withdrawn): A spindle unit according to claim 1, wherein the grease supply system includes a mechanical fixed-displacement piston pump having a check valve and a fixed-displacement piston to discharge the grease, a grease tank for storing the grease, an in-grease-tank piston for pressurizing the grease in the grease tank, and a sensor provided to the grease tank to monitor a residual amount of grease.

17. (withdrawn): A spindle unit according to claim 16, wherein the sensor has a magnet that is fitted to the in-grease-tank piston.

18. (withdrawn): A spindle unit according to claim 16 , further comprising a sensor for monitoring a pressure of the grease in the grease tank or a pressure of the grease in a grease piping that connects the mechanical fixed-displacement piston pump and the grease tank.

19. (withdrawn): A spindle unit according to claim 16, further comprising a mechanism for holding a pressure applied to the in-grease-tank piston for a predetermined time to pressurize the grease in the grease tank in a state that the fixed-displacement piston returns to a home position after the mechanical fixed-displacement piston pump operates to discharge the grease.

20. (withdrawn): A spindle unit according to claim 16, wherein the sensor controls an upper limit of the rotation speed of the spindle when the sensor senses an abnormality.

21. (withdrawn): A spindle unit according to claim 1, wherein the grease supply system includes a mechanical fixed-displacement piston pump having a grease tank for storing the grease, a cylinder for containing the grease fed from the grease tank by a predetermined amount, a fixed-displacement piston moved reciprocally in the cylinder to discharge the grease contained in the cylinder in a predetermined amount to a grease supply piping, and a check valve arranged onto an end portion of the cylinder.

22. (withdrawn): A spindle unit according to claim 21, wherein the mechanical fixed-displacement piston pump has a valve for supplying a medium into the cylinder, and the fixed-displacement piston is operated by the medium supplied via the valve.

23. (withdrawn): A spindle unit according to claim 21, wherein the grease supply piping is formed of a Teflon tube.

24. (withdrawn): A spindle unit according to claim 1, further comprising a cooling means for cooling a predetermined location by supplying a cooling fluid to an inside of the housing; and a motor having a rotor provided to the spindle and a stator provided to an inner peripheral surface of the housing to oppose to the rotor;
wherein the spindle is operated by the motor, and
the cooling means cools the stator and also cools at least the outer ring of the rolling bearing.

25. (withdrawn): A spindle unit according to claim 24, wherein the cooling means cools the spindle by supplying the cooling fluid to an inside of the spindle and passing the cooling fluid through the spindle in a longitudinal direction.

26. (withdrawn): A spindle unit according to claim 24 , further comprising a cooling fluid recovering means for recovering the cooling fluid exhausted from the spindle and the housing.

27. (withdrawn): A spindle unit according to claim 1, wherein the rolling bearing includes at least one supply hole formed in the outer ring to supply the grease to an inside of the rolling bearing, and an annular groove formed on an outer periphery of the outer ring to contain the supply hole, and

a value obtained by dividing a sectional area (mm^2) of the annular groove by a peripheral length (mm) of a cross section of the annular groove is set to 0.25 mm or more.

28. (withdrawn): A spindle unit according to claim 1, wherein the rolling bearing includes at least one supply hole formed in the outer ring to supply the grease to an inside of the rolling bearing,

the housing includes an annular groove formed on an inner periphery of the housing to face to the supply hole, and

a value obtained by dividing a sectional area (mm^2) of the annular groove by a peripheral length (mm) of a cross section of the annular groove is set to 0.25 mm or more.

29. (withdrawn): A spindle unit according to claim 27 , wherein a pair of outer annular grooves are formed on an outer periphery of the outer ring or an inner periphery of the housing on both sides of the supply hole in an axial direction, and an O ring is fitted into the pair of outer annular grooves respectively.

30. (withdrawn): A spindle unit according to claim 27 , wherein a clearance between the inner periphery of the housing and the outer periphery of the outer ring is set to 30 μm or less, and a length of a contact portion between an outer diameter surface of the outer ring and the housing in the axial direction is set to 1 mm or more.

31.-106. (canceled).

107. (new) A spindle unit according to claim 1, wherein the spindle is a machine tool spindle.

108. (new) A spindle unit according to claim 1, wherein the spindle is a high-speed motor spindle.

109. (new): The spindle unit according to claim 2, wherein the rolling elements are balls, the outer ring raceway is a raceway groove, and the supply hole is opened at a location other than the raceway groove on the inner peripheral surface of the outer ring.

110. (new): A method of supplying grease to a rolling bearing comprising:
providing a rolling bearing including an outer ring having an outer ring raceway on an inner peripheral surface and an inner ring having an inner ring raceway on an outer peripheral surface;
rollably providing rolling elements between the outer ring raceway and the inner ring raceway, whereby a spindle is borne rotatably in a housing; and
supplying the grease to an inside of the rolling bearing, where a supply amount in one shot is set to 0.004 cc to 0.1 cc.

111. (new): The method according to claim 110, wherein the rolling elements are balls, the outer ring raceway is a raceway groove, and the grease is shot out from an opening of the inner peripheral surface of the outer ring at a location other than the raceway groove.